AD-A064 201 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MISS F/G 9/2
ANALYZING SLIDING STABILITY OF STRUCTURES USING THE COMPUTER PR--ETC(U)
DEC 78 R L HALL
UNCLASSIFIED WES-INSTRUCTION-K-78-1 NL

| OF |

AD
A064201

END
DATE
FILMED
4-79
DDC

INSTRUCTION REPORT K-78-1

ANALYZING SLIDING STABILITY OF STRUCTURES USING THE COMPUTER PROGRAM GWALL

by

Robert L. Hall

Automatic Data Processing Center
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

December 1978
Final Report

Prepared for U. S. Army Engineer District, Lower Mississippi Valley
P. O. Box 80, Vicksburg, Miss. 39180

Destroy this report when no longer needed. Do not return it to the originator.

This program is furnished by the Government and is accepted and used by the recipient with the express understanding that the United States Government makes no warranties, expressed or implied, concerning the accuracy, completeness, reliability, usability, or suitability for any particular purpose of the information and data contained in this program or furnished in connection therewith, and the United States shall be under no liability whatsoever to any person by reason of any use made thereof. The program belongs to the Government. Therefore, the recipient further agrees not to assert any proprietary rights therein or to represent this program to anyone as other than a Government program.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

14

1. REPORT NUMBER

WES - Instruction ~~Report~~ K-78-1

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

9

4. TITLE (and Subtitle)

6 ANALYZING SLIDING STABILITY OF STRUCTURES USING THE COMPUTER PROGRAM GWALL.

5. TYPE OF REPORT & PERIOD COVERED

Final report,

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)

10 Robert L. Hall

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS

U. S. Army Engineer Waterways Experiment Station
Automatic Data Processing Center
P. O. Box 631, Vicksburg, Miss. 39180

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

12 35p.

11. CONTROLLING OFFICE NAME AND ADDRESS

U. S. Army Engineer Division, Lower Mississippi Valley
P. O. Box 80, Vicksburg, Miss. 39180

12. REPORT DATE

11 Dec[redacted]78

13. NUMBER OF PAGES

32

14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)

15. SECURITY CLASS. (of this report)

Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

GWALL (Computer program)
Slope stability analysis
Structural analysis
Structural stability

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report documents the usage of the computer program GWALL to analyze the sliding stability of structures. The program provides for display of input data for easy checking and editing and requires the use of a Tektronix 4014 or other terminals with same capabilities. The analysis is a wedge method slope-stability analysis that follows the design procedures used in the Lower Mississippi Valley Division for analysis of plane failures. The program provides for calculation of uplift by entering profile of force water seepage pressures.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

038 100 mt

Preface

This report documents an interactive graphics program, GWALL, to analyze the sliding stability of structures. The program is an addition to the series of slope-stability programs that were developed by Mr. J. B. Cheek, Automatic Data Processing Center (ADPC), U. S. Army Engineer Waterways Experiment Station (WES). The analysis portion of GWALL was taken from slope stability program SSW039A. Also, since most of the input for GWALL is identical to that for program SSW39A, most of the documentation in this report came directly from WES Miscellaneous Paper K-77-1, "Analysis of Slope Stability, Wedge Method Using Head Profiles to Model Uplift Pressures."

B 013 763 L

The latest work, supported by the U. S. Army Engineer Division, Lower Mississippi Valley (LMVD), to allow the use of inclined neutral block base, crack analysis, horizontal and vertical forces on neutral block, and the addition of structure geometry was completed by Mr. Robert L. Hall, ADPC, WES, under the general supervision of Mr. Cheek, Chief, Computer Analysis Branch, and Mr. D. L. Neumann, Chief, ADPC.

COL J. L. Cannon, CE, was Commander and Director of WES during the preparation and publication of this report. Mr. F. R. Brown was Technical Director.

Contents

Contents

ANALYZING SLIDING STABILITY OF STRUCTURES USING THE COMPUTER PROGRAM GWALL

Purpose and Scope

1. This report details the use of the interactive graphics program GWALL to analyze the sliding stability of structures. The report covers only the use of the program. The user's background in stability analysis is assumed to be sufficient to enable him to prepare correct data and to properly interact and evaluate the computed results.

Computation Procedures

2. The solution process used by GWALL is the same as that explained in MP K-77-1.* It is a developed cohesion, slope-stability, wedge method procedure.

Terminals

3. The user must have an interactive graphics terminal with features equivalent to the Tektronix 4014 storage tube terminal. Graphics terminals other than the Tektronix 4014 can be used with GWALL, but only after slight modification to GWALL and/or the graphics software package, Graphics Compatibility System (GCS).

Input Features

4. GWALL is very easy to use because it allows the user to interact with the program in a conversational manner. The program does not

---

* James B. Cheek, Jr., "Analysis of Slope Stability Wedge Method Using Head Profiles to Model Uplift Pressures," Miscellaneous Paper K-77-1, April 1977, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

force the user to follow a sometimes inefficient data preparation procedure, but allows the user to dictate the program action by commands which are easily learned.

5. The program assists the user in preparing input data in two ways. It displays the input graphically, as it is being defined, allowing the user to visually check what information has been input. The program also has the option of giving data preparation instruction, which is printed at the terminal following each command.

6. GWALL checks the input data and prints error messages if the data violate a program's requirement. However, this does not guarantee good data. Therefore, the program has commands that allow the user to change much of the input.

7. Thus, the combination of the graphics, the commands, the built-in data preparation instructions, and the data-checking logic enables the new user to learn quickly how to use this program.

Experienced User Convenience

8. As the user becomes proficient in the use of this program, he soon finds that the conversational mode, which was helpful during his learning phase, has become annoying. He is annoyed because he must wait while the teletype prints data preparation instructions he has already mastered by his repeated program use. To overcome this waiting problem, a special command code is provided to delete the preparation instruction associated with data input commands. This feature allows the user to quickly prepare his data without unnecessary "back talk" from the terminal. However, even an experienced user may forget the data requirements of an infrequently used command. In that case he simply uses another command code to restore the program to its full conversational mode of operation.

Prepared Data File

9. Time-sharing (T/S) computer systems do not always respond quickly to the user's commands, especially when there are many users on

the T/S computer. At such times there may be a one- or two-minute delay between the user's command to his program and the program's response. Such a slow response becomes most objectionable. To bypass this difficulty, this program can receive input data from a previously prepared data file. This data file may be quickly prepared by the user because preparation speed is not usually limited by the number of users on the T/S computer. The data may also have been prepared as the result of a prior run of this program. In either case, the user may run a long series of computations from the data in a file. When the data are entered, he may continue with his stability study, using any of the modes of operation.

Analysis

10. GWALL is a modified slope-stability analysis program. The analysis program described in MP K-77-1 is used to calculate the sliding stability of the structure.

Output

11. After the completion of each analysis, the user has the option of getting a plot at his storage tube terminal that contains the soil and water profiles, as well as the failure surface.

Overview of Operating Procedure

12. Although each facet of the operating procedure will subsequently be covered in detail, the following overview of the operating procedure may be helpful in learning how the procedures interact.

13. The user, seated at the teletype terminal, calls the computer, identifies himself, and requests a run of this program. The program asks for the name of a restart file and terminal type, which the user supplies. This file will be used to save the data that were used as input for the last stability calculations. The program then requests

a data title, which the user supplies. This title will be stored in the first line of the restart file for identification purposes. The program then asks for a command, which the user supplies. Through this command and subsequent commands, the program does any or all of the following: receives or alters soil properties, soil profiles, pool elevation, and neutral block base points; modifies the computational procedure; and evaluates stability for the data stored. GWALL also displays soil profiles, pool elevation, piezometric head points, neutral blocks, and the phrenetic profile. After investigating several failure surfaces, the user may find it necessary to sign off and attend to other duties, even though the analysis is not complete. He may do so without fear of losing his data because all the data items used in the last analysis are stored by the program in the restart file. They are ready for use when he next has an opportunity to work on the problem.

Data Preparation

14. After the proper log-on procedure and the proper run commands have been given, the program takes control of the terminal and will type:

```
GRAPHICAL WALL ANALYSIS
      BY R. HALL
       JULY 77

SUPPLY NAME OF RESTART FILE
=
```

The user supplies the desired file name and a carriage return (CR). Most computer systems will write over the existing data if the file is an existing one. Therefore, the user should give a new file name, and he should be sure that the data stored under the old file name are no longer needed. After this file is established, the program types:

```
SUPPLY TITLE FOR THIS RUN
=
```

The user supplies a title for this run that may contain up to 60 characters, including blanks. This title will be written on the first line of the restart file. By giving meaningful titles and names for the restart file, the user can keep track of files associated with specific projects. After the title is entered, the screen is erased and the program types:

```
ENTER COMMAND
=
```

The user may now begin to use commands to enter, display, and/or run stability analyses. If an invalid command is entered, the user has the option of getting a list of valid commands, as seen in Figure 1.

```
ENTER COMMAND
=XX
COMMAND UNKNOWN
DO YOU WISH A LIST OF VALID COMMANDS ? ENTER (Y OR N)
=Y

SOIL DATA
STRUCTURE DATA
PROGRAM CONTROL
NEUTRAL BLOCK
EDIT XXXX
PIEZOMETRIC HEAD
INSERT SOIL
RUN
CONVERSATIONAL OUTPUT
NO CONVERSATION OUTPUT
TABLE OF SOIL PROPERTIES
READ OLD DATA FILE
WINDOW PROFILE
DISPLAY PROFILE
DELETE XXXX
HORZ. FORCE
VERT. FORCE
```

Figure 1. List of commands

Optional Output

15. The user can receive optional data preparation instructions with each data input command. The additional instruction is referred to

as the full conversational mode. The optional output will be underlined in this report to distinguish it from the normal output.

Soil Input Command = SO

16. The program responds to command soil with:

SOIL 1 PROPERTIES

SATURATED	Q TEST		R TEST		S TEST	
UNIT WT.,	PHI,	COHESION,	PHI,	COHESION,	PHI	COHESION

=

Reply with saturated unit weight, in pounds per cubic foot; Q , R , and S test values for friction angle, phi , in degrees; and cohesion, C , in pounds per square foot. The last item is followed by CR.

17. The program stores the properties and requests:

SOIL PROFILE

X(1), Y(1), X(2), Y(2),...X(N), Y(N)

=

Supply points, distance, and elevation in feet on the exterior profile in ascending order by distance, X . Note that this exterior profile must extend beyond the surface intersection points of any wedges to be studied.

18. If more than one line of data is required for the profile, insert a comma and then CR after the last point on the line. The program will store this portion of the profile. When the program is ready for the remainder of the data, it will type an equal sign on the next line. Wait for the equal sign before supplying additional points.

19. Additional SO commands are used to input the properties and profile data for the interior soils. The program numbers each new soil in steps of one, starting with the numeral 1 for the first soil.

20. Soils must be defined working from high elevations to low, because each profile erases all portions of profiles below it. Any valid portion of a profile erased by this procedure must be

redefined with an additional lower soil.

21. The screen is erased and all data are displayed after each soil profile is defined (see Figures 2 and 3). The soil properties are

```
ENTER COMMAND
▪SO

SOIL 1 PROPERTIES

SOIL PROFILE
X(1), Y(1), X(2), Y(2), ... X(N), Y(N)
▪0,0,100,0,200,100,300,100
```

Figure 2. Input of soil data

```
ENTER COMMAND
▪
```

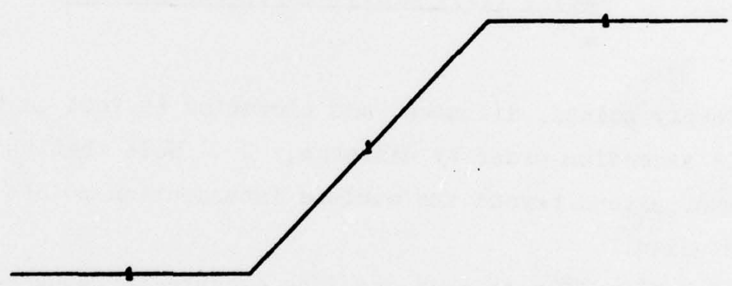

Figure 3. Display of soil data

displayed, using the same scale factor in both the X and Y directions. The scale factor is chosen to use as much of the screen as possible. If a soil profile point is improperly input, the point's X and Y coordinates can be changed by the Edit Soil command, ED SO. The soil properties can be changed by the Edit Properties command, ED PR.

<u>Structure Input Command = ST</u>

22. The program responds to command ST with:

UNIT WT. OF CONCRETE
=

Reply with the unit weight of the concrete, in pounds per cubic foot.

23. The program stores the weight and requests:

STRUCTURE PROFILE
X(1), Y(1), X(2), Y(2),...X(N), Y(N)

24. Supply points, distance, and elevation, in counterclockwise order. The first and last points must be outside the outer soil profile. The structure input should be given after all elements of the soil profile intersecting the structure have been defined. Figures 4 and 5 demonstrate the use of the ST command.

Neutral Block Command = NE

25. The neutral block command, NE, is used to input the end points of the neutral block base. The program will also allow the input of a computation control number, which is written to the restart file for use with other programs and is not used with GWALL. GWALL will allow the use of an inclined neutral block base.

26. The program responds to the NE command with:

NEUTRAL BLOCK BASE n

LEFT	RIGHT	COMPUTATION
X,Y,	X,Y,	CONTROL

=

where n is the neutral block number assigned by the program.

27. The user may continue to use the NE command to establish a group of up to 25 neutral blocks for subsequent analysis. After each neutral block is defined, it is displayed with the soil profile, as seen in Figures 6 and 7.

Program Control Command = PR

28. This command is used only when one or more of the following

```
ENTER COMMAND
=ST

UNIT WT. OF CONCRETE
=150.
 STRUCTURE PROFILE
X(1), Y(1), X(2), Y(2), ... X(N), Y(N)
=140,90,14020,127,12,127,10,180,8,
=185,-2,190,-2,189,15,150,20,150,90
```

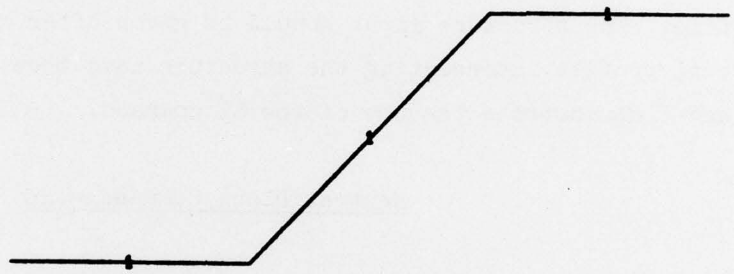

Figure 4. Input of structure data

```
ENTER COMMAND
=
```

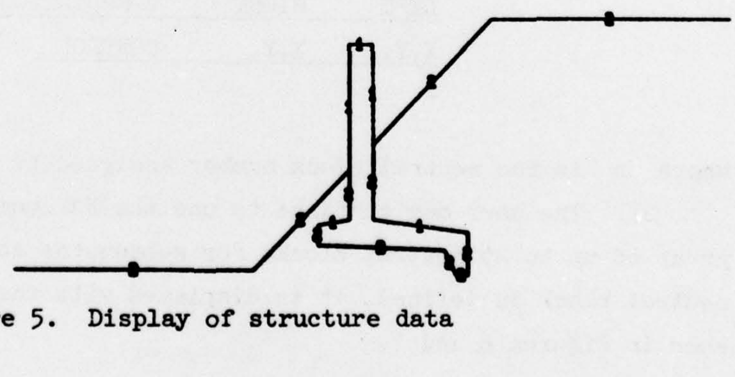

Figure 5. Display of structure data

```
ENTER COMMAND
=NE

NEUTRAL BLOCK BASE NUMBER    1
=125.-5.200.-3
```

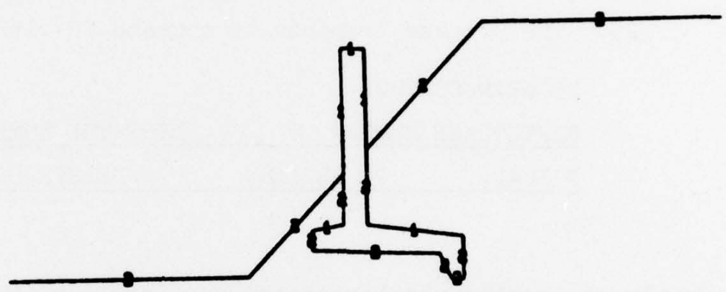

Figure 6. Input of neutral block data

```
ENTER COMMAND
=NE

NEUTRAL BLOCK BASE NUMBER    1
=125.-5.200.-3

ENTER COMMAND
=
```

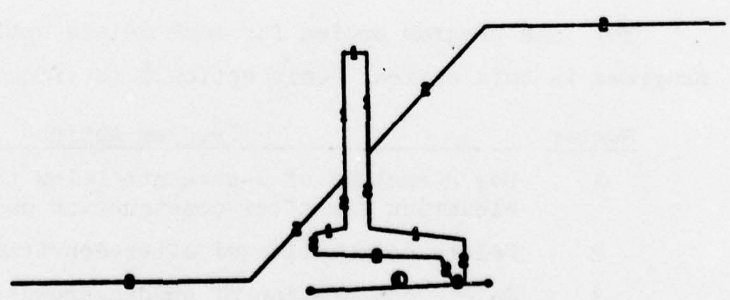

Figure 7. Display of neutral block

standard values or options are unacceptable. Items a and b apply only to the arc program.

a. Earthquake acceleration is 0.05G .

b. The number of slices is 20.

c. Program output is to include the tabulation of failure surface coordinates, weight, and head of water at each segment of the failure surface.

d. Program output is to include a tabulation of the input data.

29. The program responds to command PR with:

```
PROGRAM CONTROL
EARTHQUAKE NUMBER              LIST THE NUMBER OF EACH
G LOAD,      OF SLICES,           DELETE OPTION DESIRED
=
```

Supply the earthquake horizontal acceleration in G-units , the number of slices with a maximum of 30 (required for compatibility with the arc method program), and the number for each delete option (required for subsequent computations). All previously established delete options are removed.

Delete Options

30. The program action for each delete option is shown for all programs in this series. Only option 8 is effective in this program.

Number	Program Action
1	Use R-instead of Q-strength below the groundwater elevation for after-construction case.
2	Delete computation of after-construction case.
3	Delete computation of sudden-drawdown case.
4	Delete computation of partial and critical pool cases.
5	Delete computation of steady-seepage R-strength case.
6	Delete computation of steady-seepage S-strength case.
7	Delete computation of critical pool location.
8	Delete failure surface coordinate printing.

Horizontal Force Command = HO

31. The program responds to this command with:

```
ENTER HORZ. FORCE FOR NEUTRAL BLOCK
=
```

Enter the value, in pounds, for the horizontal force acting on the neutral block. After the force is entered, it is displayed, as in Figure 8.

Vertical Force Command = VE

32. The program responds to this command with:

```
ENTER VERT. FORCE FOR NEUTRAL BLOCK
=
```

Enter the value, in pounds, for the vertical force acting on the neutral block. After the force has been entered, it is displayed, as seen in Figure 9.

Piezometric Force Command = PI

33. The program responds to the command PI with:

```
PIEZOMETRIC HEAD POINTS
X(1),Y(1),H(1),X(2),Y(2),H(2),...X(N),Y(N),H(N)
=
```

Enter the head data profile points, consisting of the distance and evaluation of a point and the piezometric head, in feet, at that point. The points on each head data profile must be entered in ascending order of distance.

34. If more than one line of data is required for the head of any profile, follow the last head value on the line with a command, then CR. The program will store this portion of the piezometric head data. When the program is ready for additional data, it will type an equal sign on the next line. Note that the first profile must define the phreatic

```
ENTER COMMAND
=HO
ENTER HORZ. FORCE FOR NEUTRAL BLOCK
=1200.

ENTER COMMAND
=
```

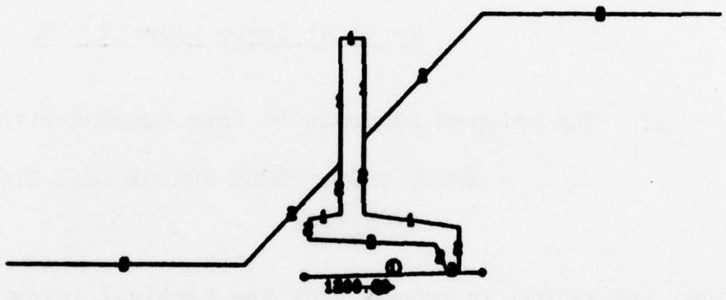

Figure 8. Input and display of horizontal force

```
ENTER COMMAND
=VE
ENTER VERT. FORCE FOR NEUTRAL BLOCK
=2000.

ENTER COMMAND
=
```

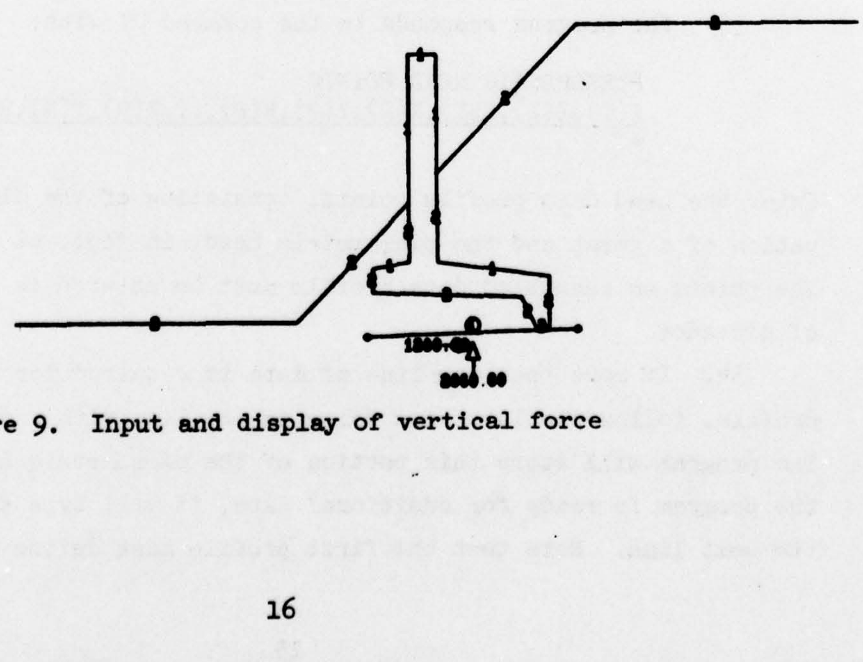

Figure 9. Input and display of vertical force

surface. (Head values must be zero.) Each additional profile is supplied by giving command PI, followed by the data for that profile. Figure 10 shows the command, as well as the display of data input.

```
ENTER COMMAND
=PI
PIEZOMETRIC HEAD POINTS
=0,0,0,100,0,0,150,50,0,300,50,0

ENTER COMMAND
=PI
PIEZOMETRIC HEAD POINTS
=0,-30,30,100,-30,30,150,-30,80,300,-30,80

ENTER COMMAND
=
```

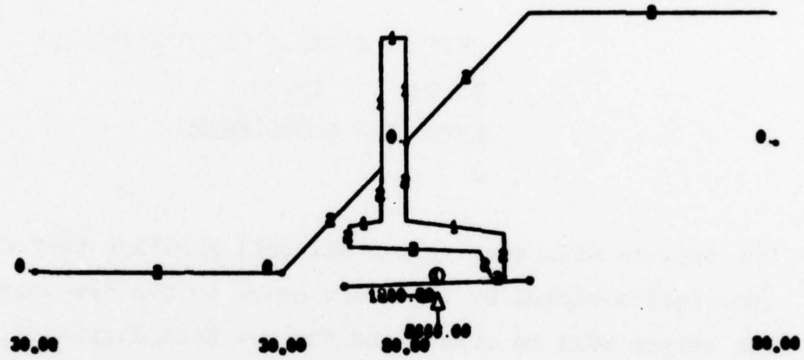

Figure 10. Input and display of piezometric head data

Change Material Properties Command = ED MA

35. The program responds to this command with:

SOIL NUMBER TO BE CHANGED
=

Reply with the number of any soil previously defined. An error message will be typed if a soil having this number is not present.

36. After locating this soil, the program types:

```
SOIL i PROPERTIES
SATURATED     Q       TEST         R   TEST          S      TEST
UNIT WT.,    PHI,    COHESION,    PHI, COHESION,    PHI,    COHESION
=
```

The symbol i is the number of the soil requested. Respond to this request with the new soil properties, as described in the section on the

SO command. All values requested must be input, even though they are the same as the previously stored data.

Edit Soil Profile Command = ED SO

37. The program responds to this command by first displaying the cross hairs. The user must then move the cross hairs to the soil profile point and enter any character and CR. The program will then respond with the following:

```
PRESENT X AND Y COORDINATES ARE
13.00      14.00
ENTER NEW COORDINATES
=
```

The program will then change all soil profiles that contain the X-Y coordinates picked by the cross hairs to the new coordinates' input. The screen will be erased and the new data displayed, as seen in Figures 11 and 12.

Edit Piezometric Head Data = ED PI

38. The program responds to this command by first displaying the cross hairs. The user must then move the cross hairs to the desired piezometric head point and enter any character and CR. The program will then respond with the following:

```
PRESENT X AND Y COORDINATES ARE
   150.00    50.00
INPUT NEW COORDINATES AND HEAD
=
```

The program will then change the piezometric head profile data. The screen will be erased and the new data displayed, as with the ED SO command.

```
ENTER COMMAND
=ED SO
```

```
PRESENT X AND Y COORDINATES ARE:
    200.00    100.00
INPUT NEW COORDINATES
=170.,100.
```

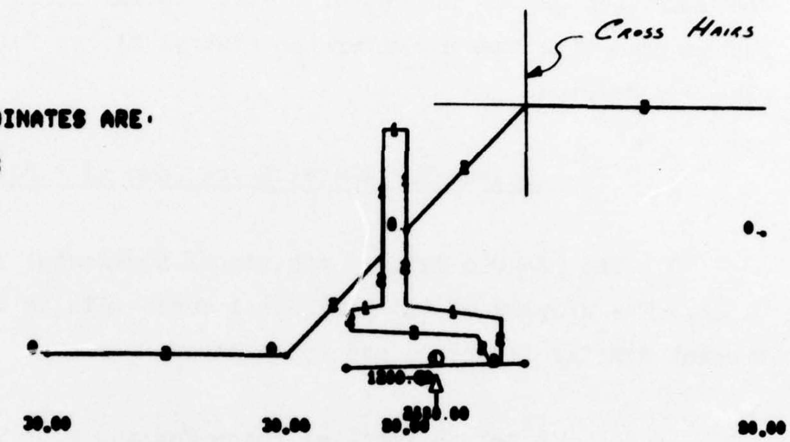

Figure 11. Editing soil data

```
ENTER COMMAND
=
```

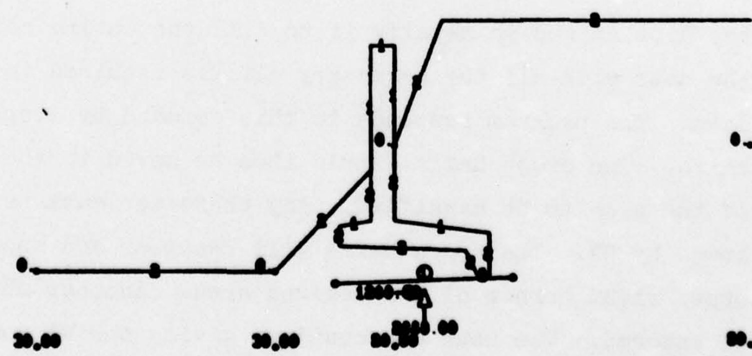

Figure 12. Display of edited soil data

Delete Neutral Block Command = DE NE

39. The program responds to this command with:

DE NE

The user then enters the number of the neutral block to be deleted. The program will then renumber the neutral blocks following the one that was deleted.

Delete Horizontal Force Command = DE HO

40. The program deletes the use of horizontal force on the neutral block. The display of the horizontal force will be deleted after the present display is erased and redisplayed.

Delete Vertical Force Command = DE VE

41. The program deletes the use of the vertical force on the neutral block. The display of the vertical force will be deleted after the present display is erased and redisplayed.

Window Command = WI

42. This command allows the user to pick any rectangular area of the display and to magnify it to fill the entire screen. This provides the user with all the necessary details required in checking the input data. The program responds to this command by displaying the cross hairs. The cross hairs should then be moved to the bottom left corner of the area to be magnified. Any character must be then entered, followed by CR. The cross hairs will reappear and should be moved to the upper right corner of the desired area. Another character and CR should be entered. The user can continue giving the WI command to window an area of the previous window. To redisplay the entire problem again, the command DI should be entered. The WI command is demonstrated in Figures 13 and 14.

ENTER COMMAND
*UI

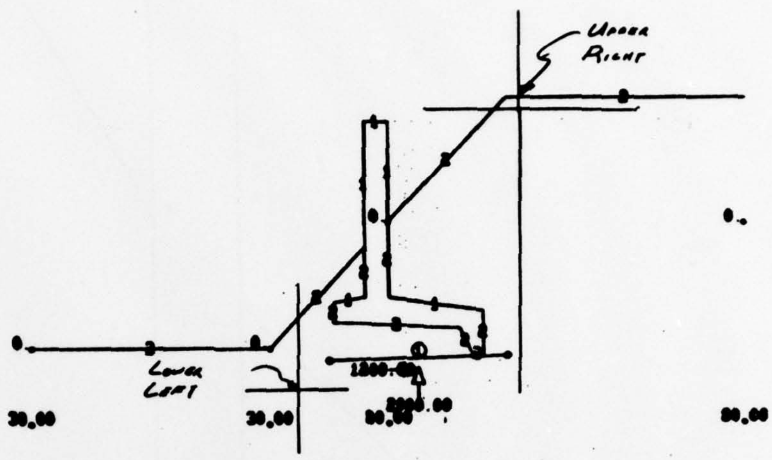

Figure 13. Window command

Display All Data Command = DI

43. The response to this command is the erasing of the screen and the displaying of all defined data, as seen in Figure 13. The display data will use as much of the screen as possible, using the same X- and Y-scale factors.

Conversational Mode Command = CO

44. The conversational mode is an optional feature that does not become effective until an invalid command or the CO command is given. The CO command causes the program to provide additional input instructions for the data input command codes.

Delete Conversational Mode Command = NO

45. This command deletes the conversational text associated with

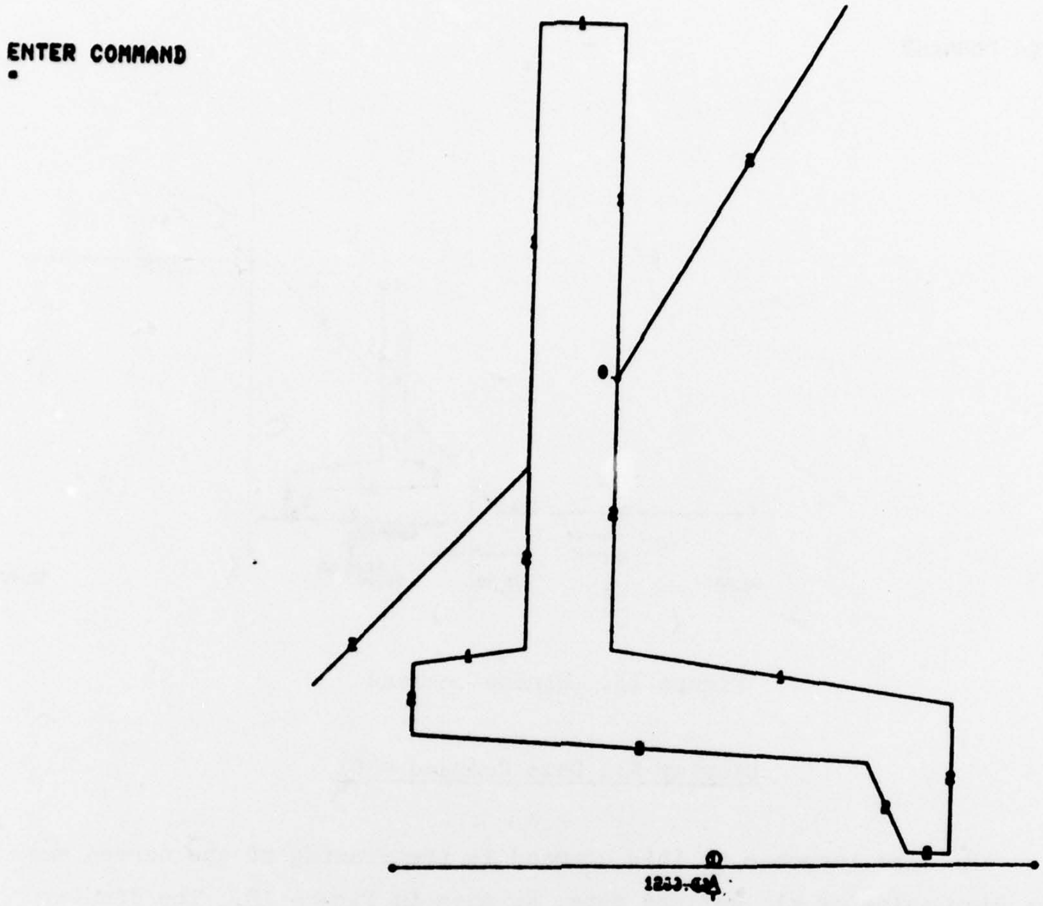

Figure 14. Results of windowing

the program's response to the command CO. As mentioned previously, the teletype output controlled by command CO is underlined in this report.

Insert New Soil Command = IN

46. This command performs the following functions:

- a. Erases all data for soils whose numbers are between N and M .
- b. Sets the program to receive a new soil (properties and profile).
- c. Inserts the new soil between numbers N and M .

d. Renumbers the soils (starting with 1 for the first soil and continuing in steps of one for all soils).

e. Sets the program to add additional soils to the end of the soil list through the command SO.

47. The program responds to the command IN with:

SOIL INSERTION NUMBERS

SOIL TO FOLLOW WILL BE PLACED BETWEEN SOIL N AND

SOIL M. N MUST BE LESS THAN M. SOILS (N+1)

THROUGH (M-1) ARE ERASED. SUPPLY VALUES FOR N AND M

=

Supply values for the soil numbers N and M . The new soil will be placed between soil N and soil M. If M is greater than N+1 , soils N+1 though M-1 will be erased and the new soil inserted. If M is greater than the last soil number, then all of the soils from (N+1) through the end of the soil list will be erased. If M is less than N , an error note will be printed. Soil N must be present or an error note will be printed.

48. The program replies with:

SOIL (N+1) PROPERTIES

=

SOIL PROFILE

=

The symbol (N+1) is the number assigned to the soil being inserted. Supply the necessary information as described in SO command, paragraphs 16-21. After an IN command, a SO command may be used to add soils to the end of the existing soil list.

49. For example, if there are six soils present and the user desires to delete soils 4 and 5 and change soil 3, he would use values of 2 and 6, respectively, for N and M . After recording the new profile and properties for soil 3, the program would renumber all soils; and in so doing, it would change the number of soil 6 to 4. If the user gives a SO command, the program will store those soil data after

soil 4, and would assign the number 5 to that new soil.

Table of Soil Properties Command = TA

50. This command provides the user with a current listing of each soil's unit weight and each soil's curves of angle of internal friction and angle of cohesion for the Q-, R-, and S-strength tests. If improper data have been entered, the user may change the material properties, with an ED MA command. The use of this command is seen in Figure 15.

ENTER COMMAND
•TA

SOIL	GAM	PHI	-	C	PHI	-	C	PHI	-	C
1	150.	0.		0.	0.		0.	0.		0.
2	112.	30.00		0.	30.00		0.	30.00		0.
1	150.	0.		0.	0.		0.	0.		0.
1	150.	0.		0.	0.		0.	0.		0.
2	112.	30.00		0.	30.00		0.	30.00		0.

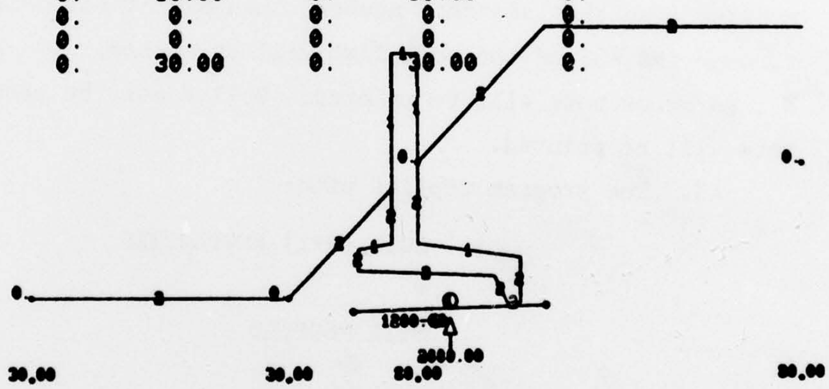

Figure 15. Table of soil properties

Execute Command = RU

51. This command causes the program to calculate the stability of the structure by a wedge method of analysis. At this time, the program also saves all data in a restart file. Figures 16 through 18 demonstrate the use of the RU command.

Execute Crack Analysis = RU CK

52. This command causes the program to calculate the stability, as

ENTER COMMAND
=RU

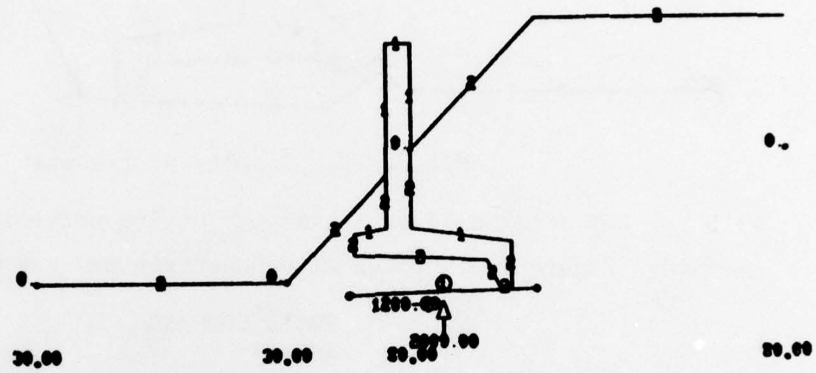

Figure 16. Run command

NEUTRAL BLOCK BASE 1
125.00, -5.00 200.00, -3.00

X	Y	WEIGHT	HEAD	SOIL
105.67	5.67	38478.	0.	2
125.00	-5.00	6856.	30.00	2
128.98	-4.96	56150.	31.92	2
140.02	-4.60	135794.	44.62	2
149.98	-4.33	424873.	54.31	2
189.82	-3.87	2542.	53.27	2
190.00	-3.87	109896.	53.27	2
200.00	-3.00	327841.	53.00	2
256.84	100.00	0.	0.	0

	L WEDGE	N BLOCK	R WEDGE	TOTAL
FD	17922.10	-18429.64	-594104.00	-594611.55
FR	18091.11	281778.88	294547.09	594417.07

S.F. =-0.916

DO YOU WANT A TEKPLOT - YES OR NO?
=YES

Figure 17. Results of analysis

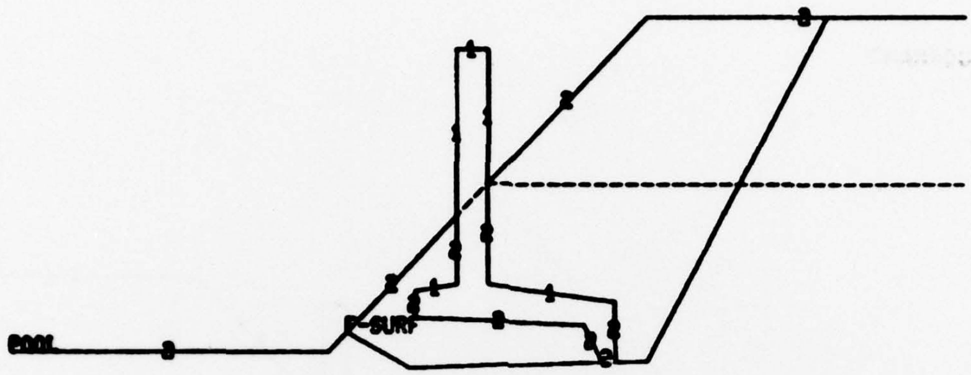

Figure 18. Display of results

with the RUN command, except that the active wedge is completely neglected. Figures 19 through 21 demonstrate the use of the RU CK command.

```
ENTER COMMAND
=RU CR
```

Figure 19. Run crack analysis command

NEUTRAL BLOCK BASE 1

125.00, -5.00 200.00, -3.00

X	Y	WEIGHT	HEAD	SOIL
105.[illegible]	5.[illegible]	331[illegible].	0.	[illegible]
125.00	-5.00	6856.	30.00	[illegible]
12[illegible]	-4.95	56150.	31.92	[illegible]
140.[illegible]	-4.60	135794.	44.62	[illegible]
149.[illegible]	-4.33	424873.	54.31	[illegible]
1[illegible]	-3.87	2548.	53.87	[illegible]
190.00	-3.87	109896.	53.87	[illegible]
200.00	-3.00	0.	53.00	[illegible]
200.00	100.00	0.	0.	0

	L WEDGE	N BLOCK	R WEDGE	TOTAL
FD	17272.30	-18429.64	-331531.25	-332688.60
FR	20447.73	312237.52	0.	332685.25

S.F. =-0.[illegible]

DO YOU WANT A TEKPLOT - YES OR NO?
=YES

Figure 20. Results of crack analysis

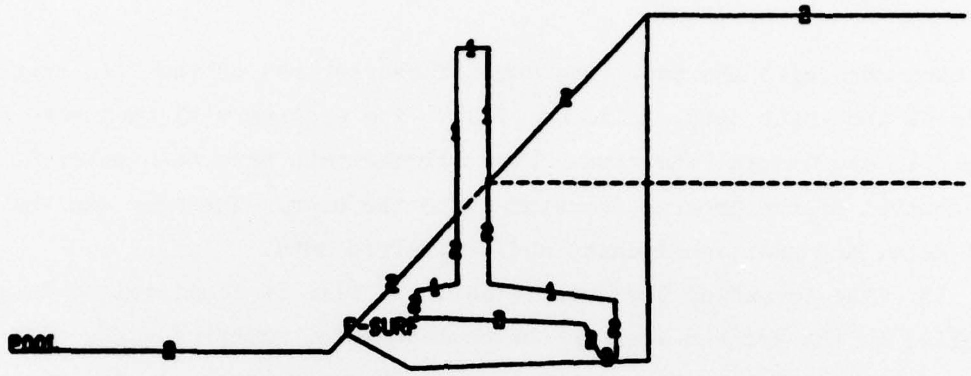

Figure 21. Display of results of crack analysis

Analysis Output

53. Figure 17 shows the output for the stability analysis for neutral block 1. This output includes the following:

- a. The coordinates, in feet, of the end points of the neutral block's base.
- b. The coordinates, in feet, of the end points that define the line segments that make up the failure surface.
- c. The weight, in pounds, of the soil above each failure surface segment.
- d. The head of water, in feet, that is effective at each end point.
- e. The number of the soil through which each failure segment passes.
- f. The tabulation of the horizontal components of the driving and resisting forces for the left wedge, neutral block, right wedge, and the total. Note that this tabulation is for the forces that were calculated for the last trial using the developed friction angle.
- g. The safety factor for this problem is printed as the last line in the output. Note that a negative sign on the safety factor indicates that the direction of failure is from right to left.

Command for Reading = RE

54. The response to this command is:

SUPPLY NAME OF INPUT DATA FILE
=

The user must give the name (maximum six characters) of the file that contains the input data, followed by CR. The program will then read the data file and display the data. When all the data have been entered, the control of the program is returned to the user. The user can then edit data, add additional data, and/or analyze data.

55. The format of the data in an input file is identical to data supplied to the program when in the command mode, except for the addition of line numbers. Figures 22 through 28 demonstrate the use of the RE command.

```
*

1000 TEST PROBLEM
1010 SO
1020 112.,30.,0.,30.,0.,30.,0.
1030 0.,0.,100.,0.,200.,100.,300.,100.
1040 ST
1050 150.
1060 140,90 140,20 127,18 127,10 180,8,
1070 185,-2 190,-2 190,15 150,20 150,90
1080 NE
1090 125.,-5.,200.,-3.
1100 PI
1110 0.,0.,0.,100.,0.,0.,150.,50.,0.,300.,50.,0.
1120 PI
1130 0.,-10.,10.,100.,-10.,10.,150.,-20.,70.,300.,-10.,60.
1140 VE
1150 2000.
1160 HO
1170 1200.
```

Figure 22. Input data file

GRAPHICAL UALL ANALYSIS
BY R. HALL
JULY 77

SUPPLY NAHE OF RESTART FILE
•RESTART
SUPPLY TITLE FOR THIS RUN
•INPUT FROM FILE

Figure 23. Entering restart file and title

ENTER COMMAND
•RE
SUPPLY NAME OF INPUT DATA FILE
•INPUT

Figure 24. Entering data file

ENTER COMMAND
•RU

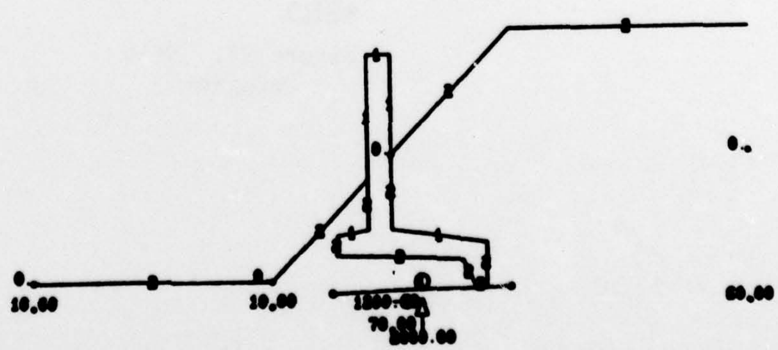

Figure 25. Display of input data and run command

```
NEUTRAL BLOCK BASE        1
    125.00,       -5.00          200.00,      -3.00

       X        Y      WEIGHT    HEAD  SOIL
   105.67     5.67     38478.     0.     2
   125.00    -5.00      6558.   30.00    2
   135.98    -4.95     56150.   31.98    2
   140.02    -4.60    135794.   44.02    2
   149.98    -4.33    484873.   54.31    2
   189.82    -3.87      2548.   53.87    2
   190.00    -3.87    109896.   53.87    2
   200.00    -3.00    327841.   53.00    2
   256.84   100.00        0.     0.     0

        L WEDGE     M BLOCK     R WEDGE       TOTAL
FD     17922.10   -18429.64  -594104.00  -594611.55
FR     18091.11   281778.88   294547.09   594417.07

S.F. =-0.916


DO YOU WANT A TEKPLOT - YES OR NO?
=YES
```

Figure 26. Results of analysis

```
ENTER COMMAND
=END
```

Figure 27. Exit program

```
10000   TEST PROBLEM
10010   SO
10015    150.00,    0.  ,    0.  ,    0.  ,    0.  ,    0.  ,    0.
10020            0.  ,      0.  ,
10030        100.00,      0.  ,
10040        140.00,     40.00,
10050        140.00,     90.00,
10060        150.00,     90.00,
10070        150.00,     50.00,
10080        200.00,    100.00,
10090        300.00,    100.00
10100   SO
10105    112.00,   30.00,    0.  ,   30.00,    0.  ,   30.00,    0.
10110            0.  ,      0.  ,
10120        100.00,      0.  ,
10130        140.00,     40.00,
10140        140.00,     20.00,
10150        127.00,     18.00,
10160        127.00,     10.00,
10170        180.00,      8.00,
10180        185.00,     -2.00,
10190        190.00,     -2.00,
10200        189.60,     15.00,
10210        150.00,     20.00,
10220        150.00,     50.00,
10230        200.00,    100.00,
10240        300.00,    100.00
10250   SO
10255    150.00,    0.  ,    0.  ,    0.  ,    0.  ,    0.  ,    0.
10260        127.00,     18.00,
10270        140.00,     20.00
```

Figure 28. Restart file (sheet 1 of 2)

```
*

10280  SO
10285   150.00,     0.  ,     0.  ,     0.  ,     0.  ,     0.  ,     0.
10290       150.00,     20.00,
10300       189.60,     15.00
10310  SO
10315   112.00,   30.00,     0.  ,   30.00,     0.  ,   30.00,     0.
10320       127.00,     10.00,
10330       180.00,      8.00,
10340       185.00,     -2.00,
10350       190.00,     -2.00
10360  NE
10365   125.00,   -5.00,  200.00,   -3.00
10370  PR
10375     0.05,20, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
10380 PI
10390       0.  ,        0.  ,        0.  ,
10400     100.00,        0.  ,        0.  ,
10410     150.00,      50.00,        0.  ,
10420     300.00,      50.00,        0.
10430 PI
10440       0.  ,     -10.00,      10.00,
10450     100.00,     -10.00,      10.00,
10460     150.00,     -20.00,      70.00,
10470     300.00,     -10.00,      60.00
10490 HO
10495    1200.00
10500 VE
10505    2000.00
```

Figure 28. (sheet 2 of 2)

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Hall, Robert L

Analyzing sliding stability of structures using the computer program GWALL / by Robert L. Hall. Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1978.

32 p. : ill. ; 27 cm. (Instruction report - U. S. Army Engineer Waterways Experiment Station ; K-78-1)

Prepared for U. S. Army Engineer Division, Lower Mississippi Valley, Vicksburg, Miss.

1. GWALL (Computer program). 2. Slope stability analysis. 3. Structural analysis. 4. Structural stability. I. United States. Army. Corps of Engineers. Lower Mississippi Valley Division. II. Series: United States. Waterways Experiment Station, Vicksburg, Miss. Instruction report ; K-78-1.
TA7.W34i no.K-78-1